Linking electricity prices and costs in bottom-up top-down coupling under changing market environments

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SAEE/SCCER CREST Conference

Energy: economics, consumer and firm behavior, policy and regulation

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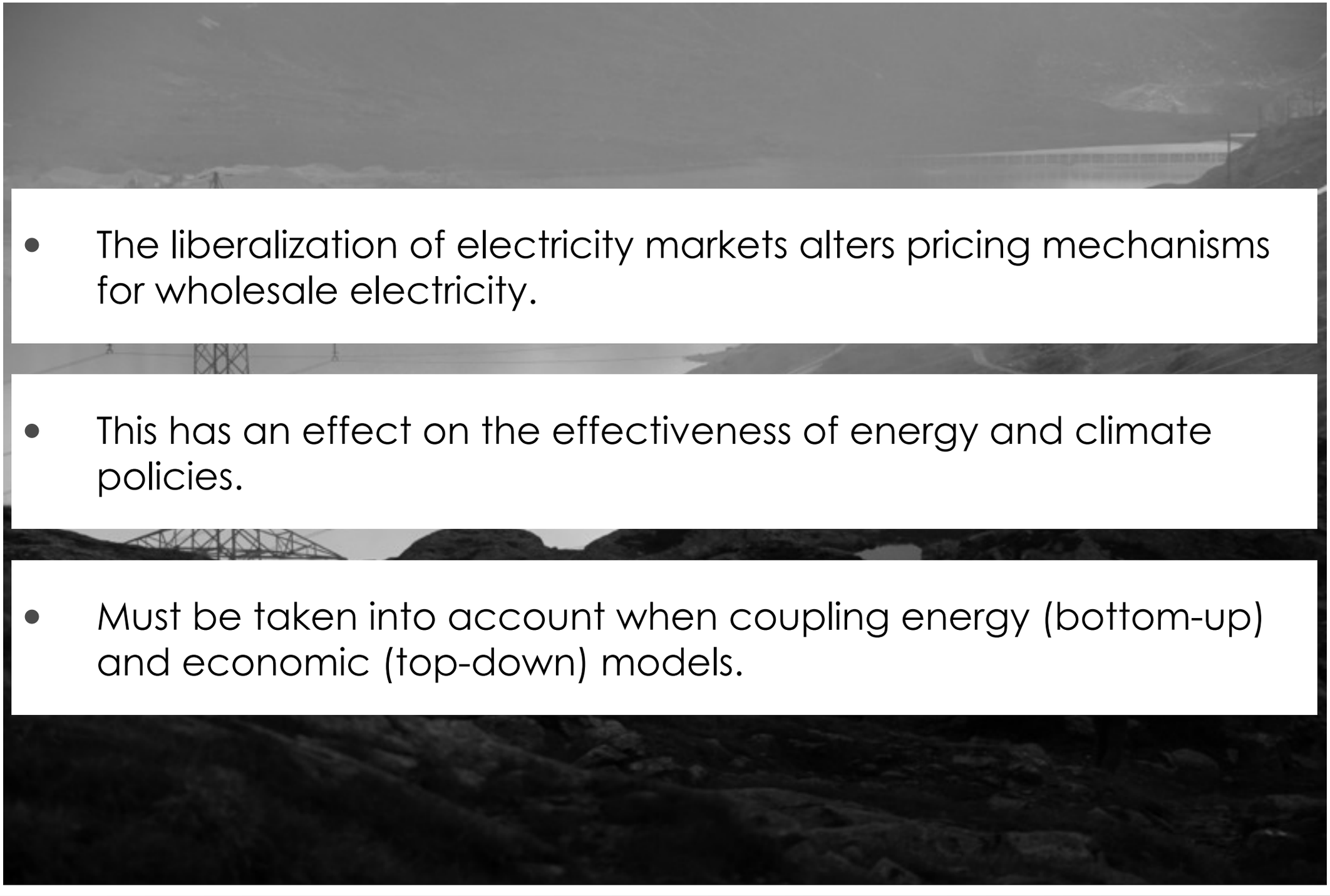
Econability
Sustainable Economics in Research and Practice

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

In essence

Doris Leuthard. (Photo : Vanina Moreillon)

My talk in a nutshell



- The liberalization of electricity markets alters pricing mechanisms for wholesale electricity.

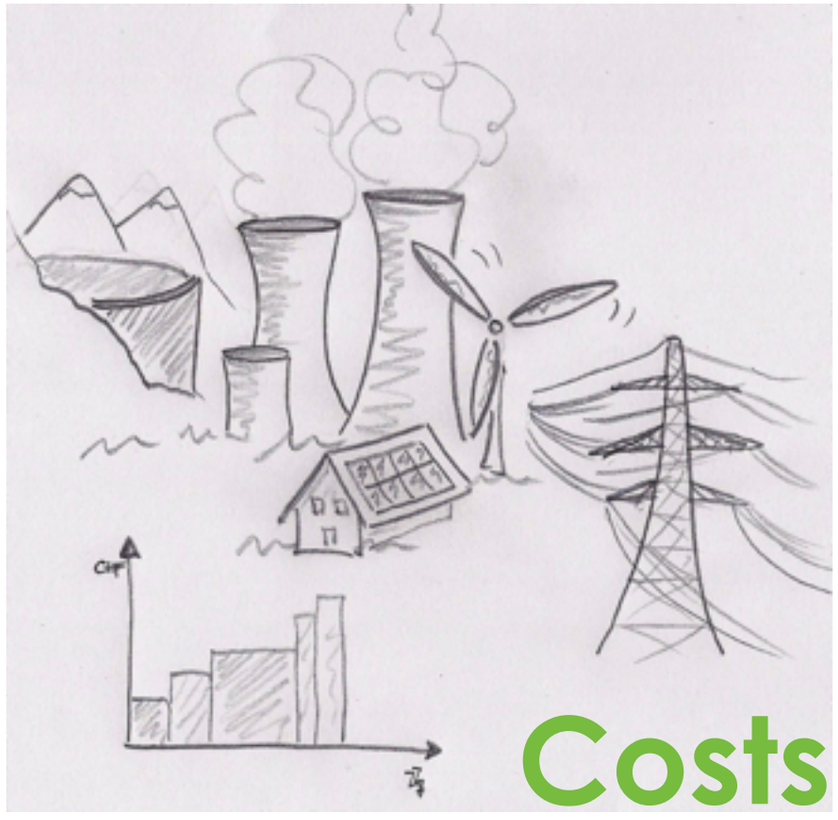
- This has an effect on the effectiveness of energy and climate policies.

- Must be taken into account when coupling energy (bottom-up) and economic (top-down) models.

Structure

- Electricity market liberalization and wholesale electricity pricing
- The ELECTRA framework
- Scenarios
- Results
- Conclusion

Costs vs prices



Couple

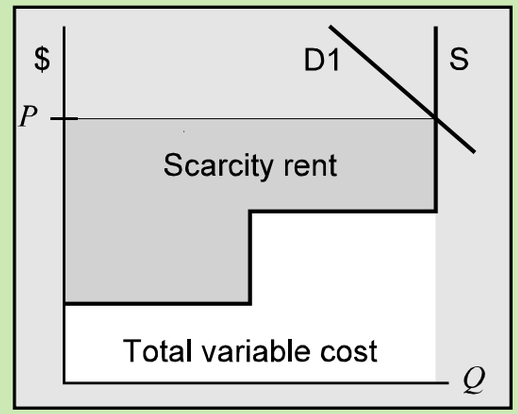
Costs ⟷ **Link** ⟷ **Prices**

TIMES electricity supply model

Computable General Equilibrium (CGE) model

In the CGE model, prices drive the decisions of economic agents!

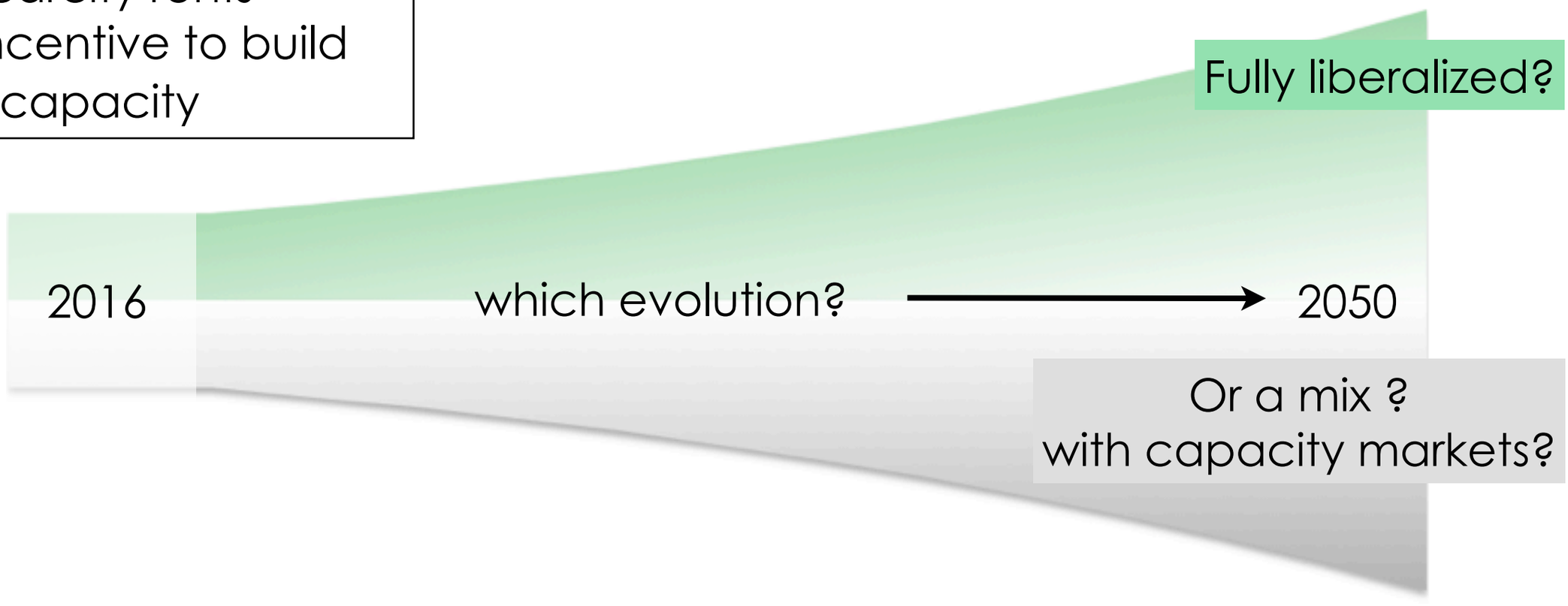
Wholesale electricity pricing

	Traditionally regulated market	**Fully liberalized market**
Wholesale electricity pricing	Regulated prices: • cover generation costs • acceptable profit	Priced: • at marginal cost • including scarcity rents 
Incentive for new capacity addition	• guaranteed acceptable return on investments • subsidies (open or covert)	• scarcity rents reach the right level at equilibrium
Modeling	price = AC + profit	price = MC (incl. scarcity rents)

European electricity market

Largely liberalized market

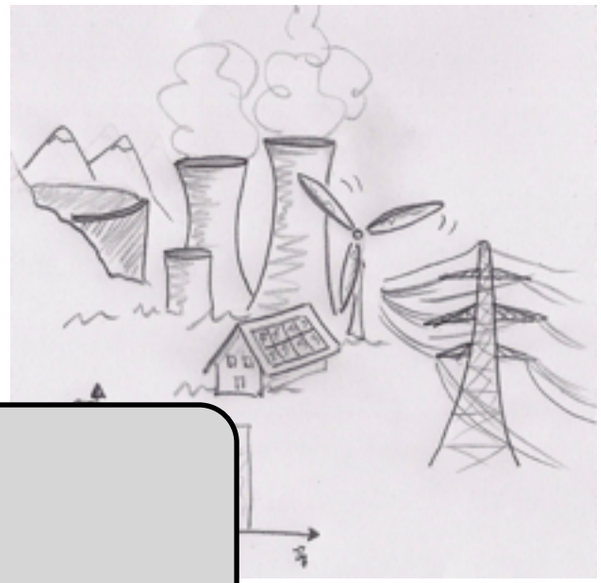
Situation of overcapacity
⇒ no scarcity
⇒ no scarcity rents
⇒ no incentive to build new capacity



ELECTRA

- ELECTRA : Electricity markets and trade in Switzerland and its neighboring countries
- Project partners:
  - EPFL, Ecole Polytechnique Fédérale de Lausanne
    Sophie Maire, Philippe Thalmann, Marc Vielle, Frédéric Babonneau
  - Econability, Mühleturnen
    Frank Vöhringer
  - PSI, Paul Scherrer Institute, Villigen
    Rajesh Pattupara, Kannan Ramachandran, Hal Turton
- Financed by the Swiss Federal Office of Energy

Models



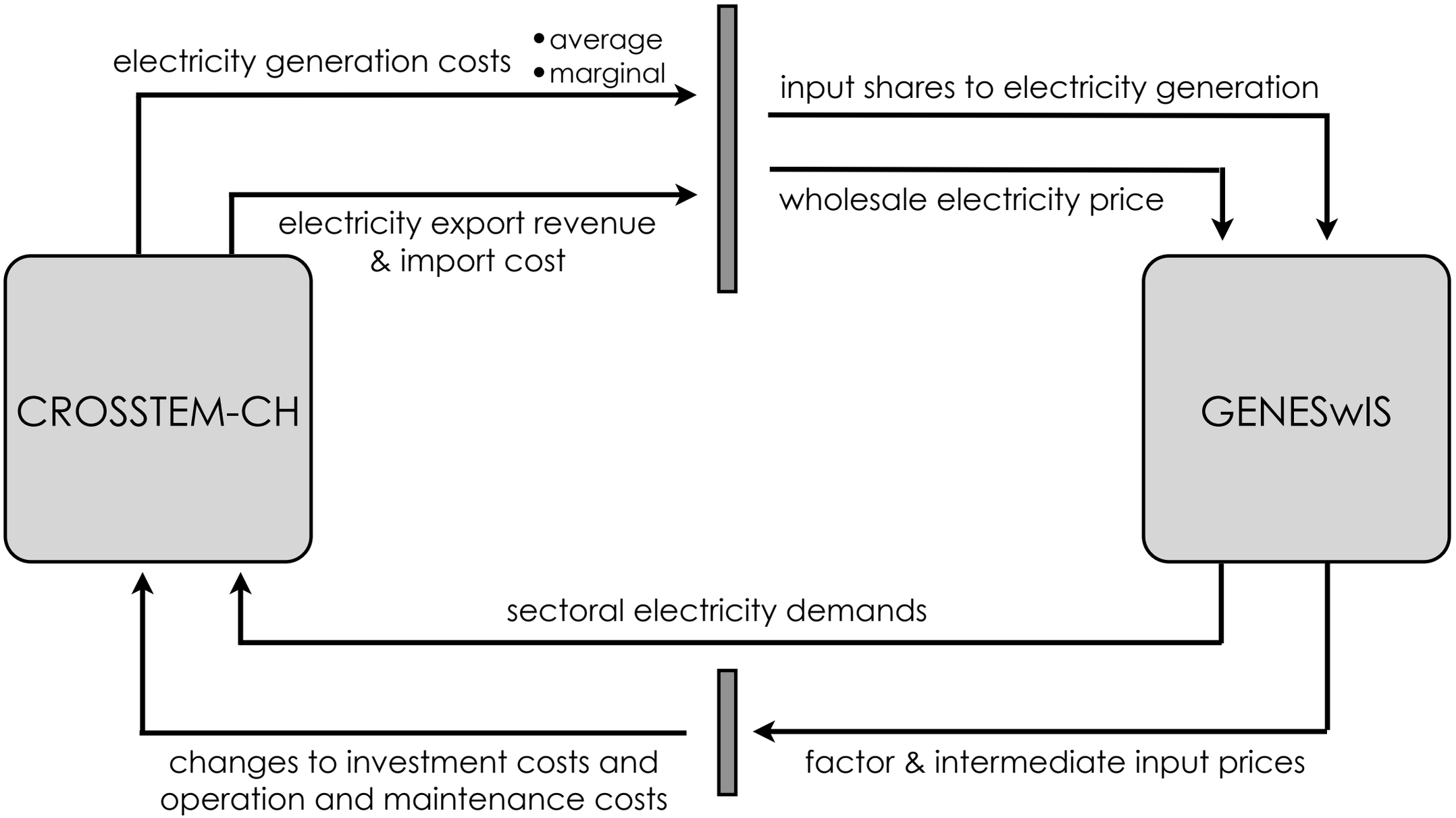
CROSSTEM-CH

Cross-border Swiss
TIMES Electricity Model

GENESwIS

General equilibrium
model (CGE) of the
Swiss economy

Coupling


electricity generation costs
• average
• marginal
input shares to electricity generation
wholesale electricity price
electricity export revenue
& import cost
CROSSTEM-CH
GENESwIS
sectoral electricity demands
changes to investment costs and
operation and maintenance costs
factor & intermediate input prices

Scenarios

		Pricing scenarios	
		Regulated market	Liberalized market
Policy scenarios	Baseline	BAU_REG	BAU_LIB
	Tax scenario	TAX_REG	TAX_LIB

Scenarios

		Pricing scenarios	
		Regulated market	Liberalized market
Policy scenarios	**Baseline**	Swiss BAU scenario ETS scheme (linked with EU ETS) CO_2 tax on heating fuels and gas	
	Tax scenario	Electricity tax (10% in 2020, 50% in 2050) Increase CO_2 tax CO_2 tax on transport fuels (from 2035)	

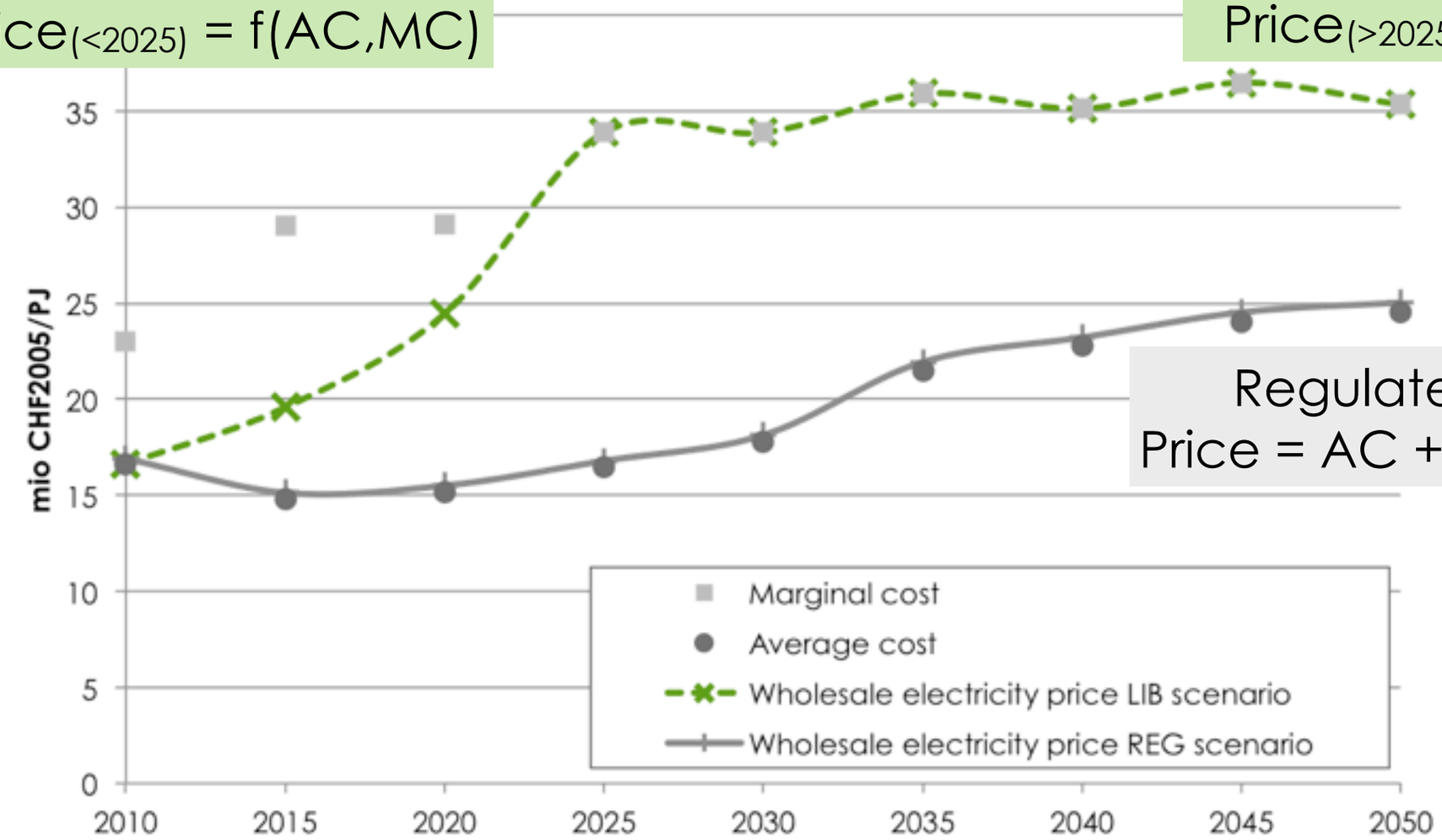
Scenarios

		Pricing scenarios	
		Regulated market	**Liberalized market**
Policy scenarios	Baseline	**price = AC + profit**	**price = MC** (incl. scarcity rents)
	Tax scenario		

Costs and prices

Liberalized market
Price(<2025) = f(AC,MC)

Liberalized market
Price(>2025) = MC



Regulated market:
Price = AC + profit markup

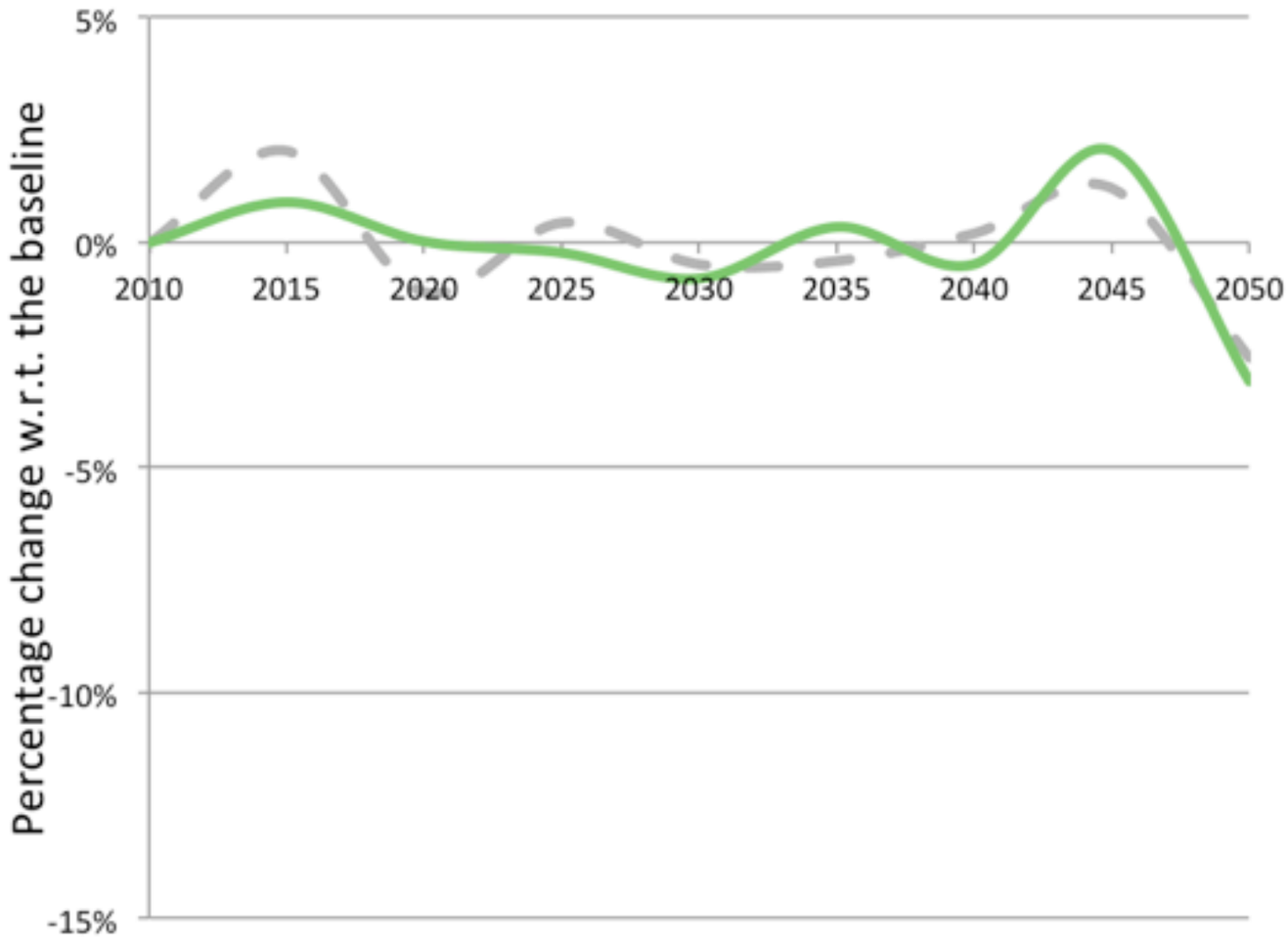
Wholesale electricity price assumptions with regards to average and marginal cost from the CROSSTEM-CH model.

Variation btw scenarios&baselines

		Pricing scenarios	
		Regularized market	Liberalized market
Policy scenarios	Baseline	BAU_REG	BAU_LIB
	Tax scenario	TAX_REG	TAX_LIB

- **price for users ↑**
- **demand↓**

MC and AC variation

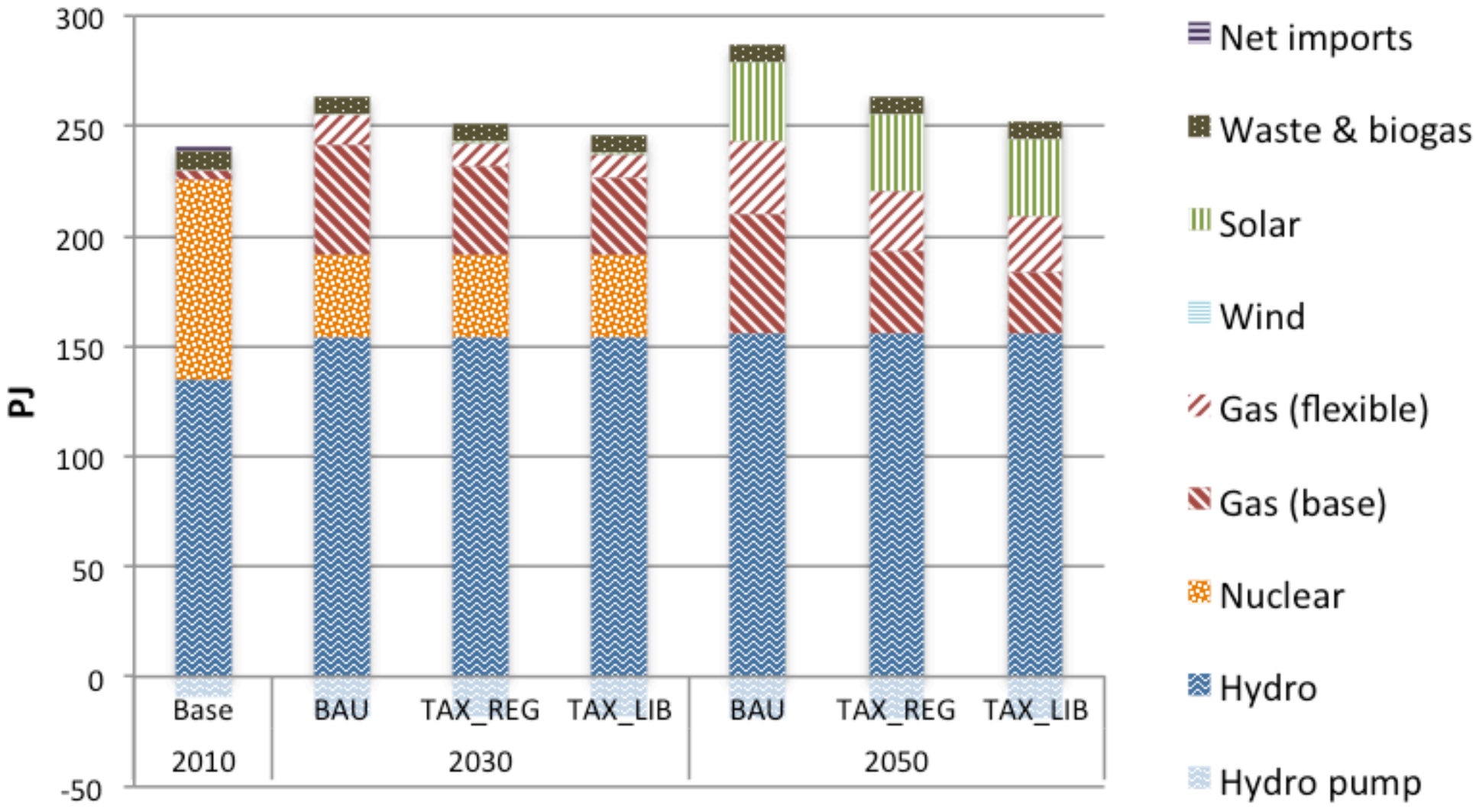


MC Liberalized market

MC Regulated market

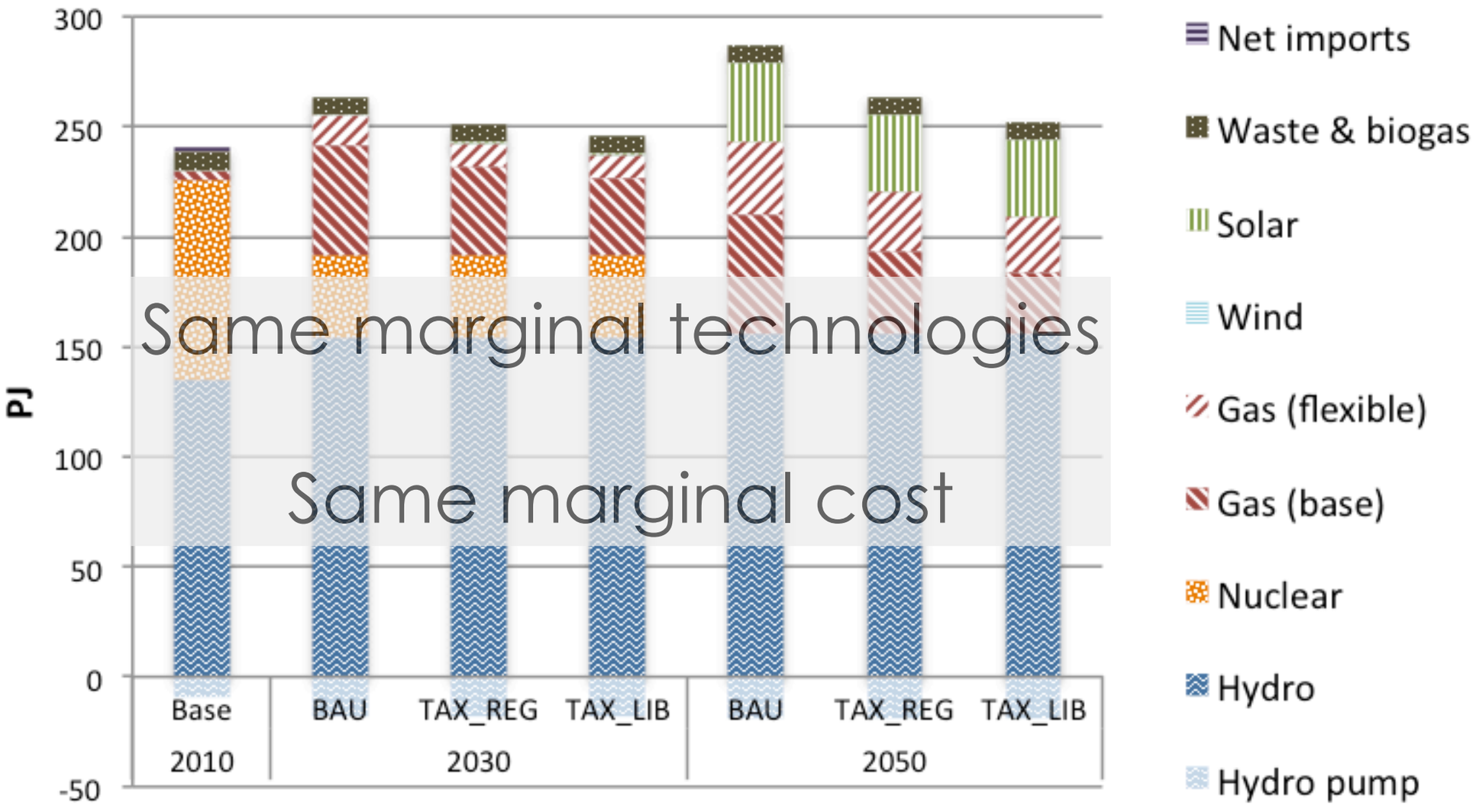
Percentage change of the marginal cost and average cost in the TAX scenarios for liberalized and regulated markets, relative to the respective baselines

AC&MC variation - Generation mix



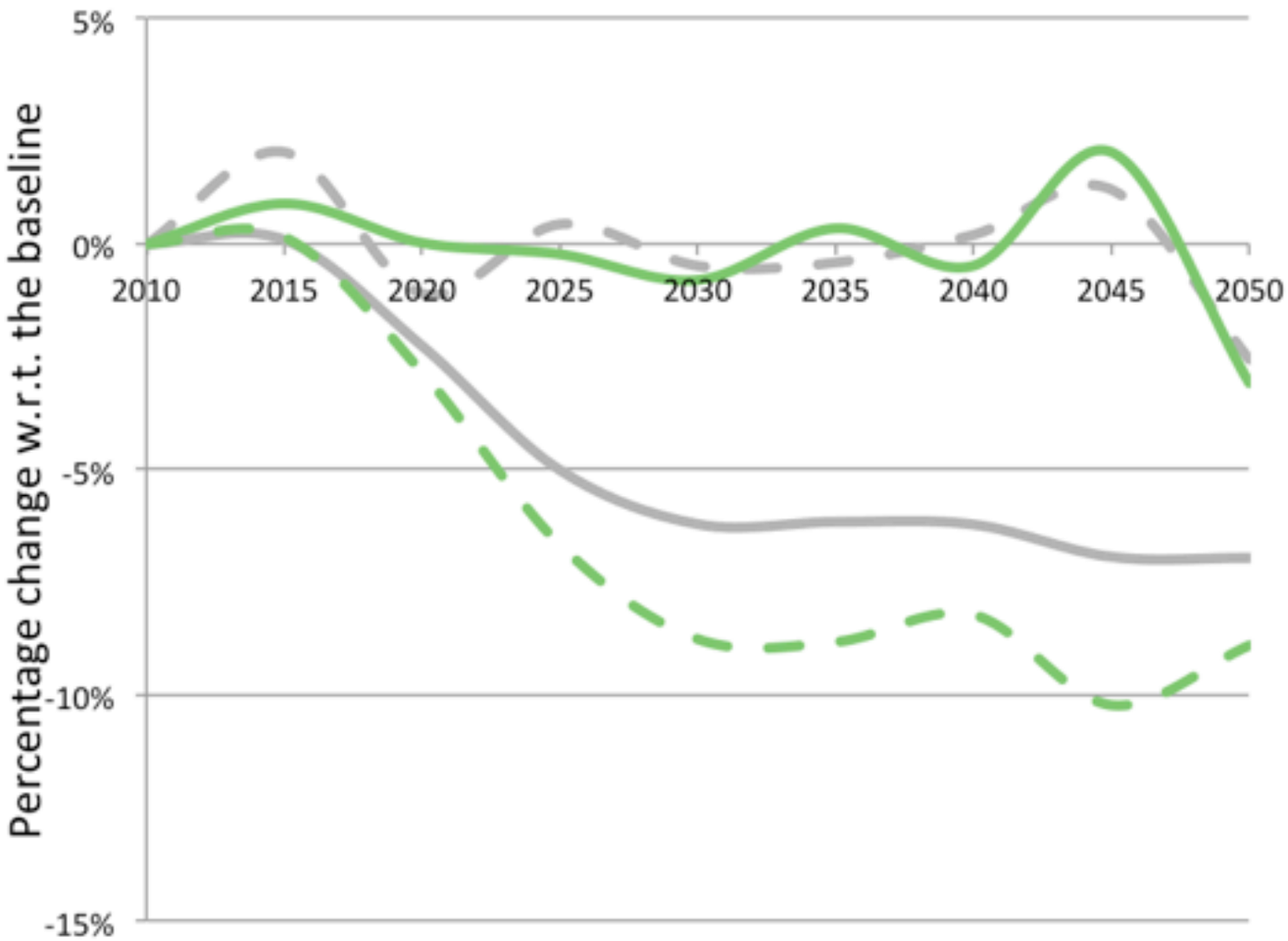
Electricity generation mix for the baselines and TAX scenarios for liberalized and regulated markets for 2030 and 2050.

AC&MC variation - Generation mix



Electricity generation mix for the baselines and TAX scenarios for liberalized and regulated markets for 2030 and 2050.

MC and AC variation



MC Liberalized market

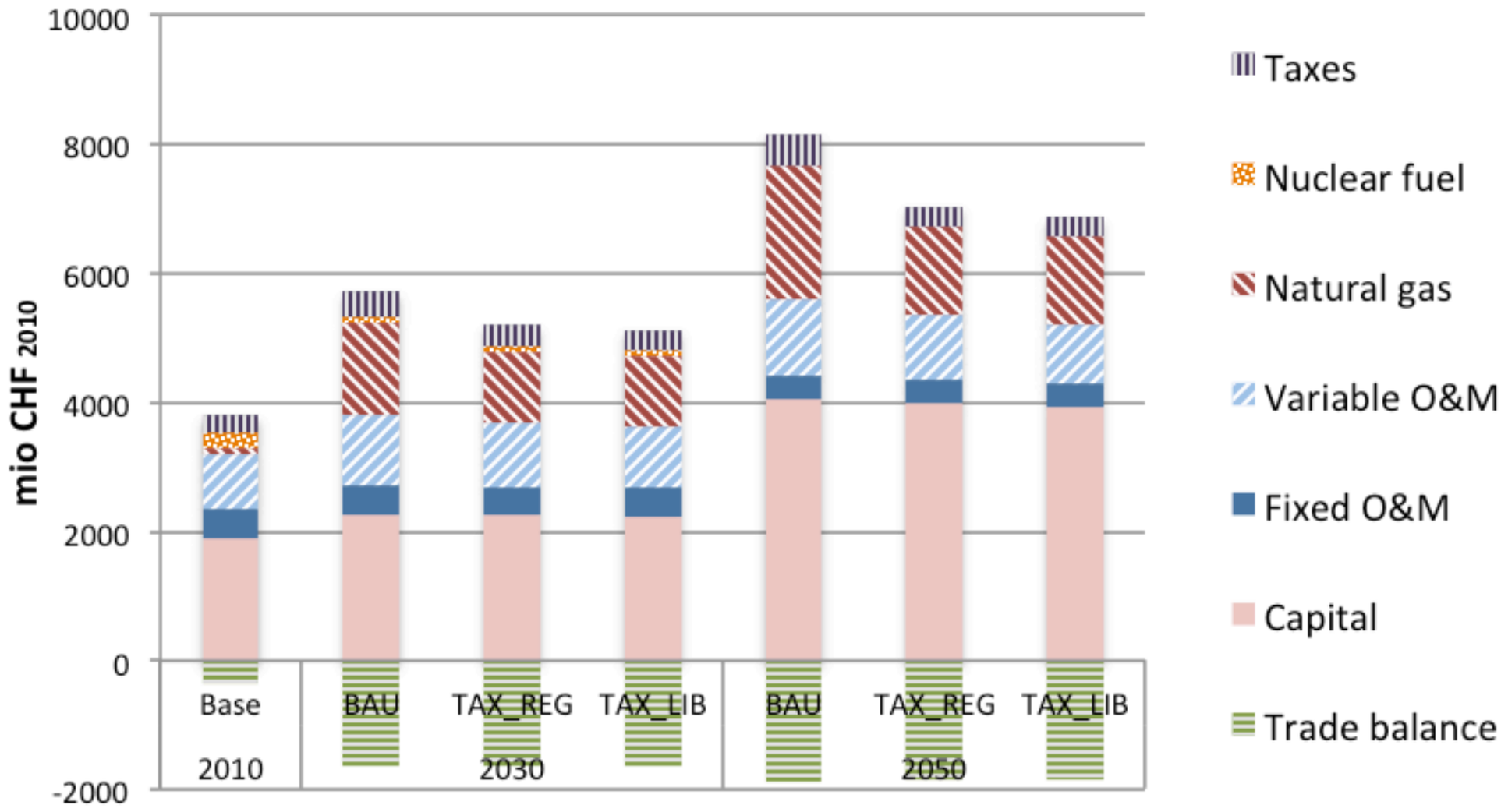
MC Regulated market

AC Regulated market

AC Liberalized market

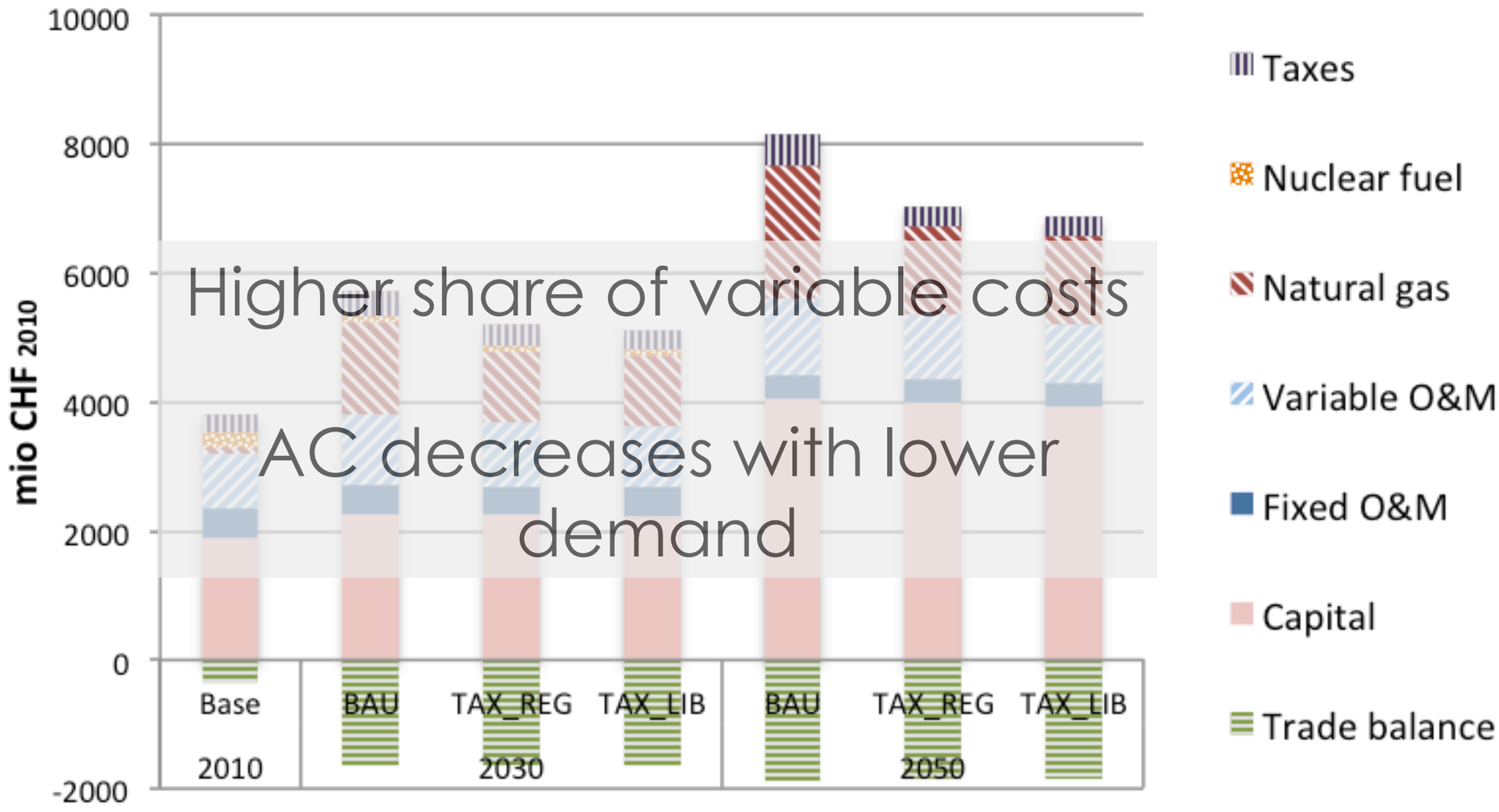
Percentage change of the marginal cost and average cost in the TAX scenarios for liberalized and regulated markets, relative to the respective baselines

MC&AC variation - system cost



Electricity generation costs for the baselines and TAX scenarios for liberalized and regulated markets for 2030 and 2050.

MC&AC variation - system cost

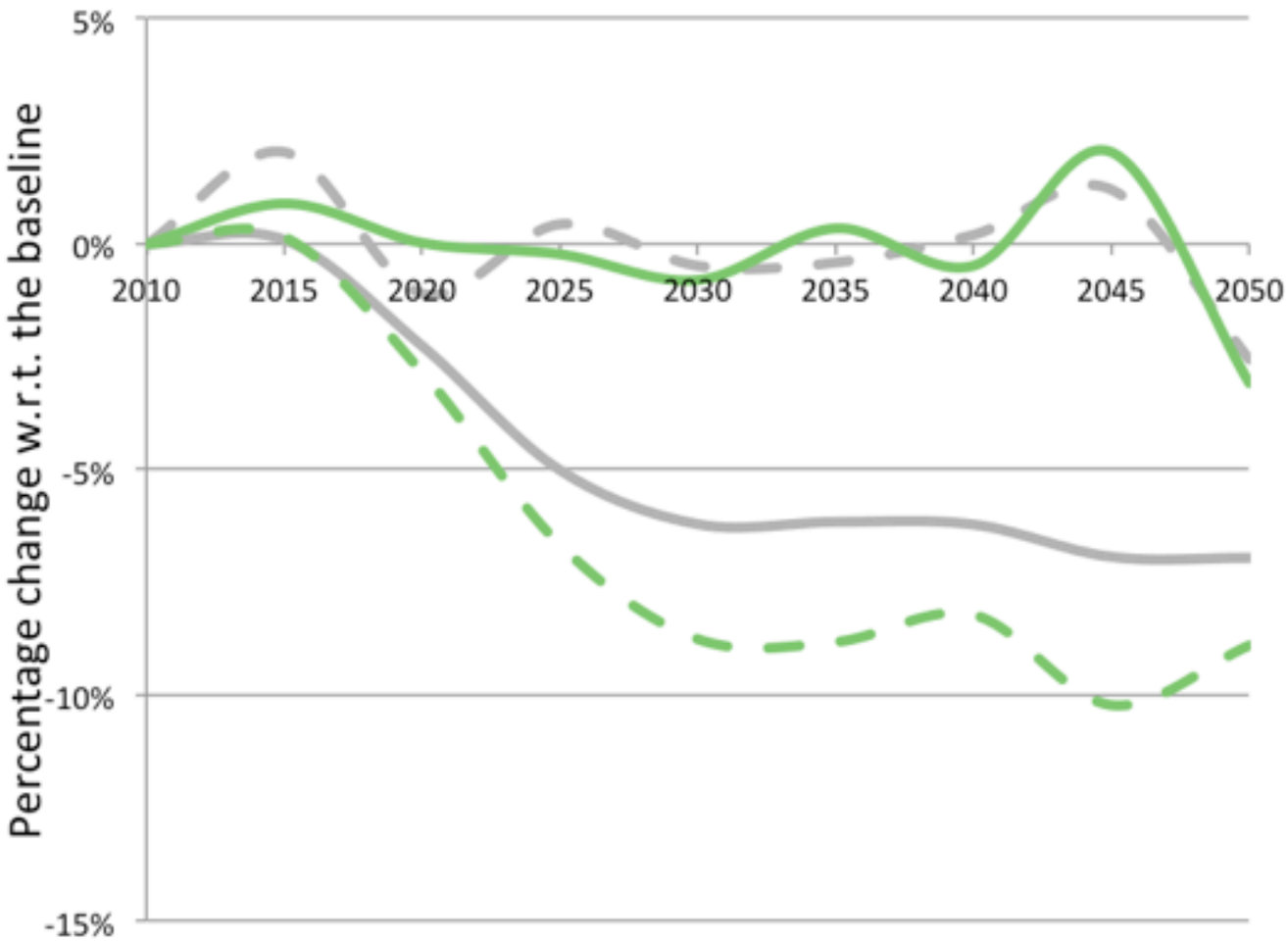


Higher share of variable costs

AC decreases with lower demand

Electricity generation costs for the baselines and TAX scenarios for liberalized and regulated markets for 2030 and 2050.

MC and AC variation



MC Liberalized market

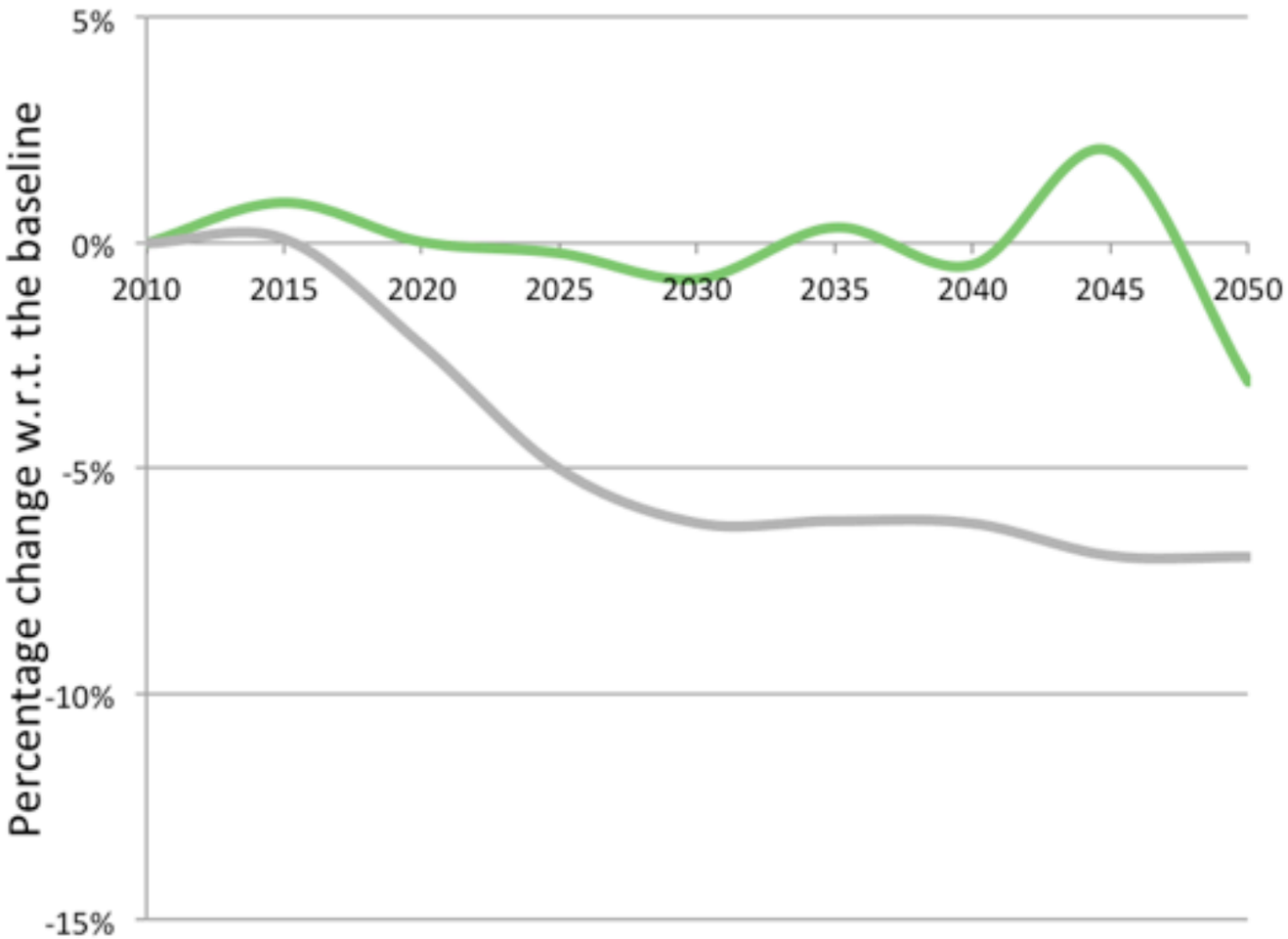
MC Regulated market

AC Regulated market

AC Liberalized market

Percentage change of the marginal cost and average cost in the TAX scenarios for liberalized and regulated markets, relative to the respective baselines

Wholesale electricity prices variation

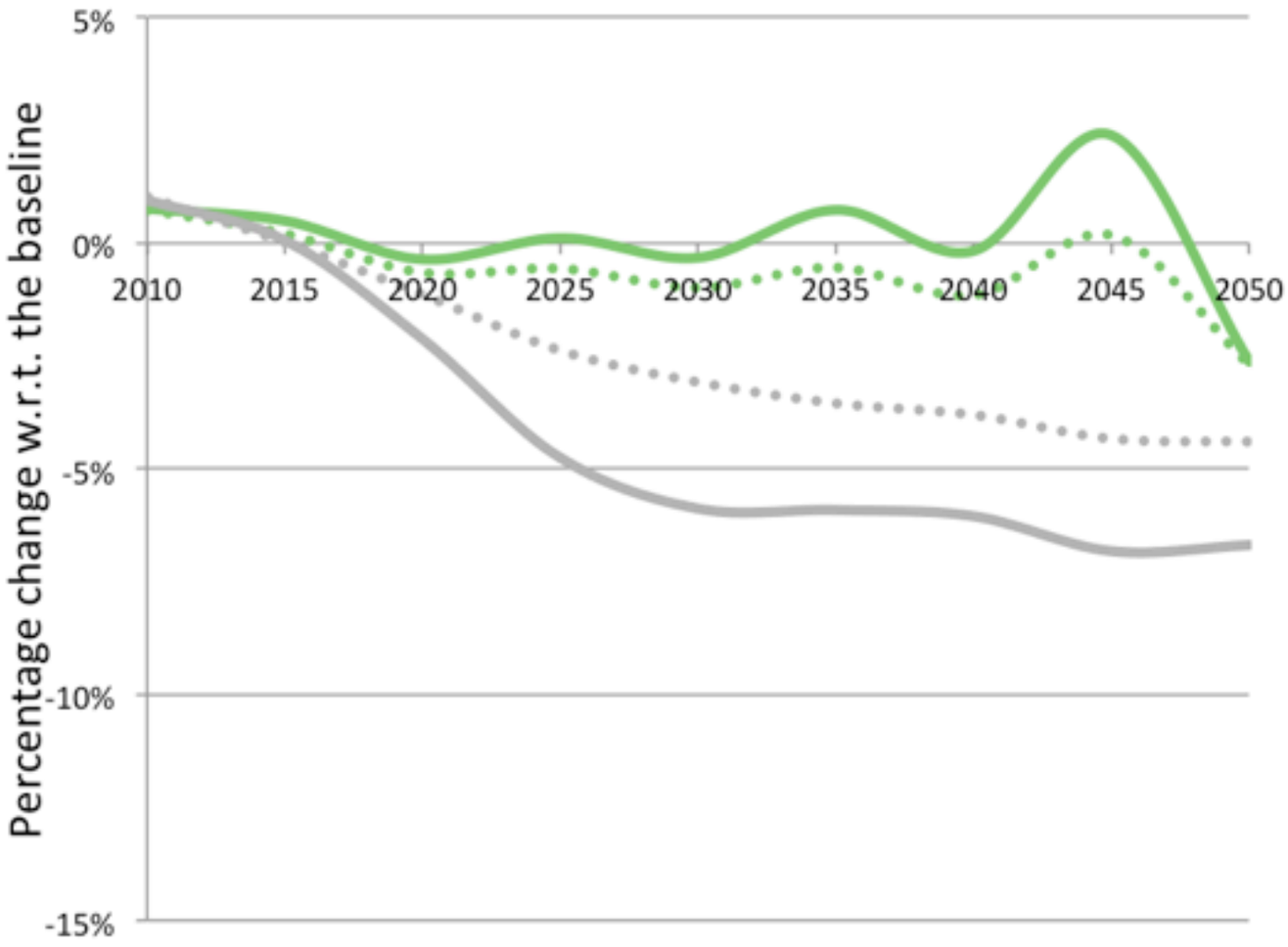


Wholesale electricity price
Liberalized market

Wholesale electricity price
Regulated market

Percentage change of electricity generation price in the TAX scenarios for liberalized and regulated markets, relative to the respective baselines

Retail electricity prices variation



Wholesale electricity price Liberalized market

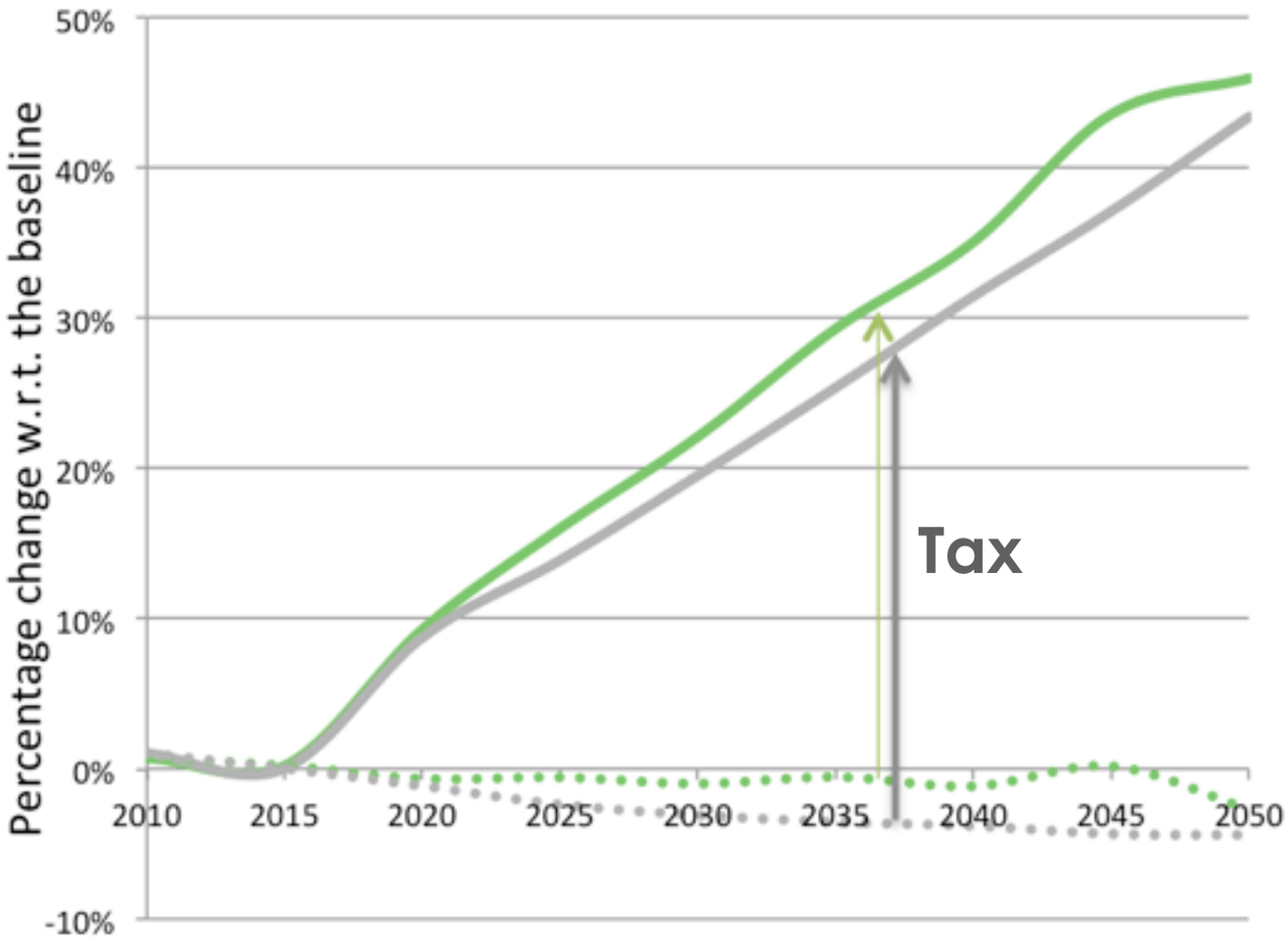
Retail electricity price Liberalized market

Retail electricity price Regulated market

Wholesale electricity price Regulated market

Percentage change of electricity generation and retail electricity prices in the TAX scenarios for liberalized and regulated markets, relative to the respective baselines

User prices variation

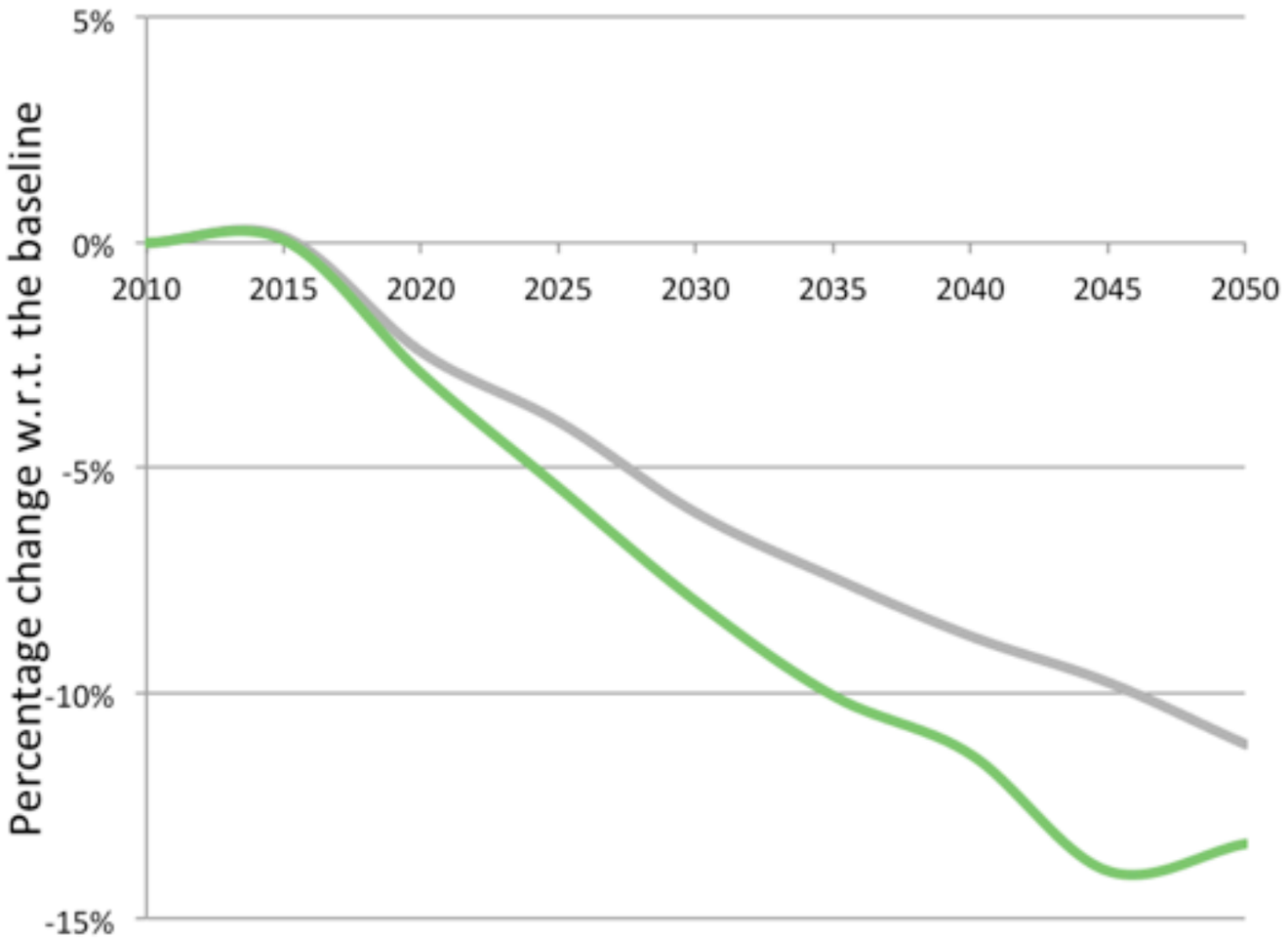


User price of electricity
Liberalized market

User price of electricity
Regulated market

Percentage change of the user price for electricity in the TAX scenarios for liberalized and regulated markets, relative to the respective baselines

Electricity demand variation



Electricity demand Regulated market

Electricity demand Liberalized market

Percentage change of electricity demand for the TAX scenarios for liberalized and regulated markets, relative to the respective baselines

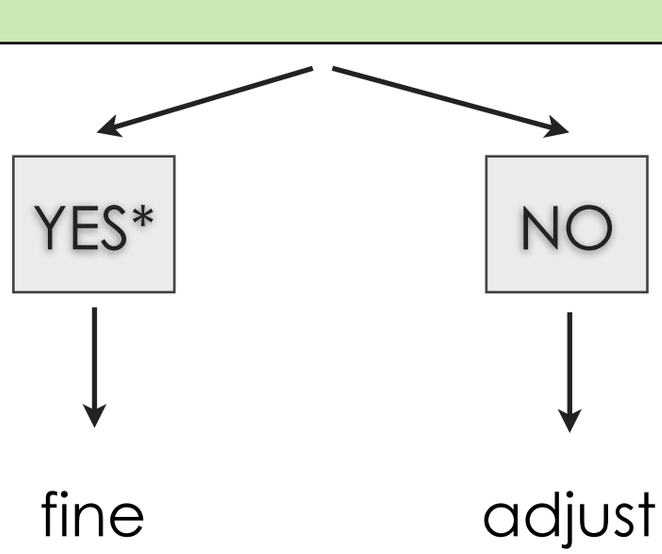
Conclusion

- In our simulations, an electricity tax is more effective in reducing electricity demand in a liberalized market than under cost-plus regulation

Conclusion

Implications for Energy Modeling: **Market liberalization matters!**

Do we use the right pricing assumptions?



Conclusion

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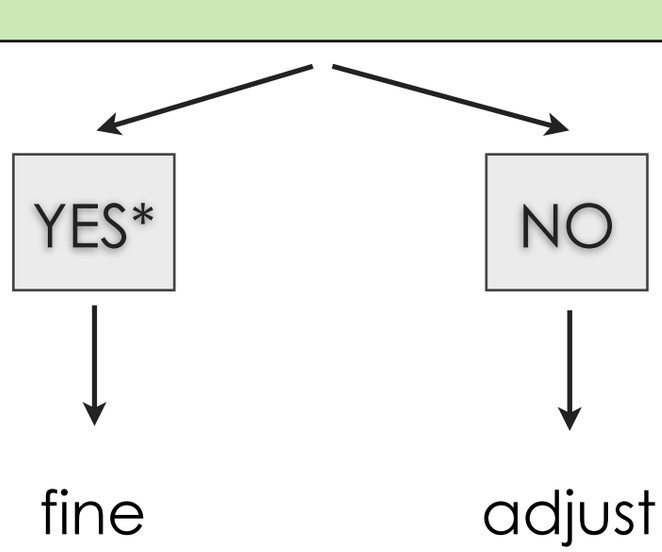

In any case, communicate the assumptions!